

# Epitomes

## Important Advances in Clinical Medicine

### Nuclear Medicine

*The Council on Scientific Affairs of the California Medical Association presents the following inventory of items of progress in nuclear medicine. Each item, in the judgment of a panel of knowledgeable physicians, has recently become reasonably firmly established, both as to scientific fact and important clinical significance. The items are presented in simple epitome, and an authoritative reference, both to the item itself and to the subject as a whole, is generally given for those who may be unfamiliar with a particular item. The purpose is to assist busy practitioners, students, researchers, or scholars to stay abreast of these items of progress in nuclear medicine that have recently achieved a substantial degree of authoritative acceptance, whether in their own field of special interest or another.*

*The items of progress listed below were selected by the Advisory Panel to the Section on Nuclear Medicine of the California Medical Association, and the summaries were prepared under its direction.*

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#### Use of Thallium 201 in Tumor Evaluation

THALLOUS CHLORIDE Tl 201 is a safe, nontoxic radiopharmaceutical currently used to assess myocardial perfusion and viability. Its use has been increasing recently to detect tumors and to characterize tumor viability. This agent has been reported as being highly successful in the evaluation of brain tumors, thyroid cancer, parathyroid adenoma and carcinoma, carcinoma of the breast, primary bone tumors, soft tissue sarcomas, lymphoma, and several other tumor types.

The mechanism of  $^{201}\text{Tl}$  uptake in tumors appears to be related to its physical similarity to potassium. It has been demonstrated that the sodium-potassium-adenosine triphosphatase membrane transport system as well as a chloride-dependent cotransport mechanism, also within the cell membrane, are the two main mechanisms of transporting thallium into the tumor cell.

Because  $^{201}\text{Tl}$  entry into the tumor cell is dependent on active transport functions requiring intact energy-generating systems, viability studies can be done using this agent. These studies have shown thallium to be an excellent marker of viability. The success of tumor therapy can be determined by measuring the change in  $^{201}\text{Tl}$  tumor levels following a baseline evaluation. An increase in thallium activity after therapy indicates therapeutic failure, and a reduction in thallium activity within a tumor appears to be proportional to the success of the therapeutic regimen.

Thallous chloride Tl 201 has also been used successfully in differentiating malignant from benign disorders. Most hilar or mediastinal masses within the chest that are malignant will take up substantial amounts of  $^{201}\text{Tl}$ , but sarcoidosis appears to take up little, if any. In addition, malignant neoplasms of the breast have been shown to take up  $^{201}\text{Tl}$ , with sensitivities approaching 96% for palpable lesions. In contrast, fibrocystic changes, which may also cause palpable breast masses, show no  $^{201}\text{Tl}$  uptake. The use of  $^{201}\text{Tl}$ -thallous chloride has also been successful in differentiating certain benign bone abnormalities from malignancy. A variety of tumors are particularly suited for thallium examination, including osteogenic sarcomas, Ewing's sarcoma, and malignant fibrous histiocytoma.

Thallium imaging can be started immediately after ad-

ministration and the study completed in one hour. The safety of the study has been demonstrated with no serious side effects. Radiation exposure is minimal. A disadvantage associated with thallium imaging is unpredictable gastrointestinal excretion that does not allow an accurate evaluation of the abdominal area. The brain, neck, chest, axilla, breast, and inguinal areas as well as skeletal system can be easily and accurately evaluated.

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#### REFERENCES

- Kim KT, Black KL, Marciano D, et al: Thallium-201 SPECT imaging of brain tumors: Methods and results. *J Nucl Med* 1990; 31:965-969
- Ramanna L, Waxman AD, Binney G, Waxman S, Mirra J, Rosen G: Thallium-201 scintigraphy in bone sarcoma: Comparison with gallium-67 and technetium-MDP in evaluation of chemotherapeutic response. *J Nucl Med* 1990; 31:567-572

#### Technetium 99m-Hexamethyl Propyleneamine Oxime-Labeled Leukocytes for Diagnosis of Infection

INDIUM 111 ( $^{111}\text{In}$ ) has been the primary radioisotope used to label leukocytes for detecting abscesses. Technetium 99m ( $^{99\text{m}}\text{Tc}$ ), the most commonly used radioisotope in nuclear medicine, has a number of important advantages over  $^{111}\text{In}$ . Until recently, however, there have not been effective methods for labeling leukocytes with  $^{99\text{m}}\text{Tc}$ .

Technetium 99m-hexamethyl propyleneamine oxime ( $^{99\text{m}}\text{Tc}$ ]HMPAO) is a new radiopharmaceutical agent commonly used in brain imaging as a marker of cerebral blood flow. The complex is small, neutral, and lipophilic, allowing it to readily cross the intact blood-brain barrier. These same characteristics enable it to be used to label leukocytes. When incubated with leukocytes, the lipophilic  $^{99\text{m}}\text{Tc}$  complex crosses the plasma membrane and changes into a more hydrophilic complex that is trapped in the cell.

In vitro and in vivo studies of leukocyte chemotaxis and function following labeling with  $^{99\text{m}}\text{Tc}$ ]HMPAO have found no evidence of cellular damage. Comparisons of  $^{99\text{m}}\text{Tc}$ ]HMPAO-labeled cells with  $^{111}\text{In}$ -labeled leukocytes and the use of gallium citrate Ga 67 in infected patients indicate that  $^{99\text{m}}\text{Tc}$ -labeled leukocytes are equal, and in many cases superior, to the standard radiopharmaceuticals. Sensi-